ANALYSIS OF POLLUTION LEVEL OF SOIL AND WATER BODY IN GOKANA LOCAL GOVERNMENT AREA OF RIVERS STATE

Ulasi, A. O., Ikezue, E. N. and Nwanakezie, M. N.
Department of Chemical Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli.
Tel. : +2348034538231

ABSTRACT

The analysis of the pollution was carried out using some parameters on both samples (water and soil) to determine their level in terms of pH, electrical conductivity (E.C), dissolved oxygen (DO), biological oxygen demand (BOD_5), sulphate, chromium, nitrate-nitrogen, phosphorous (P), phosphate ($P_2 0_5$), copper ion, oil/Grease, etc in order to determine the extent of pollution. The results obtained from the polluted water analysis were pH (7.46), E.C. (123.33µs/cm), DO (7.4mg/L), sulphate (31.66mg/L), chromium (0.22mg/L), copper (0.21mg/L), Iron (21.1mg/L), Nickel(0.02mg/l), BOD_5 (6mg/L), nitrate-nitrogen (31.19mg/L), Phosphorous (3.35mg/L), oil/Grease (6.98mg/L), etc while results obtained from soil sample analysis for heavy metals concentration were pH (7.46), oil/Grease(69.58) and (22.13)%. The AAS result (parameters) from soil sample determined include lead (ppm) 56.011, Iron (ppm) 68.191, copper (ppm) 0.897, chronuim (ppm) 1.092, etc for top soil (0-15cm) while for the subsoil (15-30cm depth) lead (ppm) 57.011, Iron (ppm) 69.698, copper (ppm) 0.532, chromuim (ppm) 0.701, etc respectively. The values obtained from laboratory work were subsequently compared with WHO standard and it was found that the values were very much higher, thus indicating serious environmental degradation in terms of pollution of water and soil.

Key words: Analysis, Pollution, Oil Spillage, Soil and Water.

1.0 INTRODUCTION

Oil spillage is a global phenomenon that has been occurring since the discovery of petroleum, which was a component of the industrial revolution. The Shell British Petroleum (now Royal Dutch shell) discovered crude oil in Nigeria in 1956 at a village Oloibiri in Bayelsa State, located within the Niger Delta region of Nigeria (Anifowose, 2008; Onuoha, 2008). The commercial production of crude oil began in 1958. But, as of 2006, there were already eleven (11) oil companies operating one hundred and fifty-nine (159) oil fields, and one thousands four hundred and eighty-one (1,481) wells in the Niger Delta. Human activities coupled with those of oil exploration and exploitation activities had rendered the Niger Delta region almost near unhabitable, which raised a number of issues such as depletion of biodiversity, coastal and river banks erosion, flooding, oil spillage, gas flaring, noise pollution, sewage and wastewater pollution, land degradation, soil fertility loss and deforestation, which are critical environmental issues. Oil exploration and exploitation (production) had been going on for several decades in the Niger Delta which has had disastrous and devastating impacts on the environment in the region and had adversely affected the host communities inhabiting the region. Odeyumi and Ogunseitan (1985) reviewed extensively on the growth and development of the oil and petrochemical industries in Nigeria with special emphasis on the notable cases of pollution disturbances during the 25 years of its existence, highlighting causes, and effects on the social, economic, agricultural and ecological characteristics on human and other biotic occupants of the oil-rich region.

Ukoli (2005) explained oil spillage as the accidental discharge or release of oil product(s) to the environment (water and soil) which may include but not limited to crude oil, diesel (AGO), premium motor spirit (PMS), grease and vegetable oil- a situation that might have been occasioned by equipment failure due mainly to corrosion, mal-operation, age or human

error and/or economic sabotage. The level of spillage and damage caused depends on the degree of what was spilled, where it was spilled, how much was lost as well as how long it had been there before the commencement of control operations. To safeguard the human component and ecosystems, recommendations were given as guide for the activities of the Nigerian National Petroleum Corporation (NNPC) in the prevention, control, treatment of oil and petrochemical pollution. As such, this study therefore seeks to:

i. Evaluate the degree of the spillage by use of chemical analysis on soil and water samples
ii. Examine the effect of the spillage on soil and water samples in Gokana local government area

2.0 REVIEW OF RELATED LITERATURE

Zabbey (2005) examined the impacts of extractive Industries on the Biodiversity of the Gokana L.G.A of Niger Delta Region. The study was guided by three research studies and experimental design was adopted. The data used was a primary data and the data collected was analysed using one way analysis of variance. The findings revealed that industrial extract has a negative impact on the biodiversity of the Niger delta region. Worgu, (2000) examined the relationship between hydrocarbon exploitation, environmental degradation and poverty in the Gokana L.G.A of Niger Delta Region of Nigeria. The main aim of the study was to determine the effect of hydrocarbon exploitation on the environmental degradation. The study was guided by two research questions and descriptive survey design was adopted. The data used was a primary data collected through structural questionnaire. The data collected was analysed using simple mean and Z-test with the aid of statistical package for social science. The findings showed that hydrocarbon exploitation has a great effect on the environmental degradation of the Gokana L.G.A of Niger delta thereby leading to massive poverty in the area. Umeh, (2004) examined the Industry and environmental pollution in Niger delta, Nigeria. The study was guided by one research question and descriptive research design was adopted. The data used was a primary data collected through structural questionnaire. The data collected was analysed using chi-square. The findings revealed that the oil companies have caused a lot of environmental pollution in the Gokana L.G.A of Niger Delta region. Tolulope, (2004) examined the impact of oil exploration on environmental degradation in Nigeria. The study was guided by one research question and descriptive research design was adopted. The data used was a secondary data collected from the Nigerian bureau of statistics. The data collected was analysed using Z-test. The findings revealed that the oil exploration has a significant effect on the environmental degradation in the Niger-Delta region especially Gokana L.G.A.

Osuji, Adesiyan & Obute (2004) examined the post impact assessment of oil pollution in the Agbada West Plain of Niger Delta Nigeria. The main aim of the study was to determine the effect of hydrocarbon exploitation on the environmental degradation. The study was guided by two research questions and descriptive survey design was adopted. The data used was a primary data collected through structural questionnaire. the data collected was analysed using simple mean and Z-test with the aid of statistical package for social science. The findings showed that hydrocarbon exploitation has a great effect on the environmental degradation of Gokana L.G.A of the Niger delta thereby leading to massive poverty in the area. Opukri, & Ibaba (2008) examined oil induced environmental degradation and internal population displacement in Niger- Delta. The study was guided by two research questions and descriptive survey design was adopted. The data used was a primary data collected through structural questionnaire. The data collected was analysed

using simple mean and Z-test with the aid of statistical package for social science. The findings revealed that oil induced environmental degradation has a great impact on internal population displacement in the Niger- Delta region especially Gokana L.G.A. Onuoha, (2008): examine the effect of oil pipeline sabotage on the environmental pollution in Nigeria. The study was guided by two research questions and descriptive survey design was adopted. The data used was a primary data collected through structural questionnaire. The data collected was analysed using simple mean and Z-test with the aid of statistical package for social science. The findings revealed that oil pipeline sabotage led to a high environmental pollution. Omofonmwan, & Odia (2009) carried out a study on oil exploitation and conflict in the Niger Delta Region of Nigeria. The study was guided by two research questions and descriptive survey design was adopted. The data used was a primary data collected through structural questionnaire. The data collected was analysed using simple mean and Z-test with the aid of statistical package for social science. The findings revealed that oil exploitation has caused so many conflicts in the Niger Delta Region of Nigeria as a result of high environmental pollution.

3.0 MATERIALS AND METHOD OF SOLUTION

The preparation of working solution or sub-stock solution from the standard stock solution of 1000ppm for different metals using the dilution formular or factor:

$C_1V_1 = C_2V_2$ (1)

Where C_1 = Conc. of the working solution = 100ppm.

V_1 = Volume of distilled water used to prepare the working solution = 100ml

And

C_2 = Conc. Of copper stock solution = 1000ppm

V_2 = Volume of stock that will be used

Then, applying equation (1) above, we have:-

$100ppm \times 100ml = 1000ppm \times V_2$

$$V_2 = \frac{100ppm \times 100ml}{1000ppm} = 10ml \qquad (2)$$

i.e.V_2 = 10ml of stock solution + 90ml of distilled water.

V_2 = 100ml of stock solution that will be used.

Thus,

$$\text{Bulk Density of the Soil} = \frac{\text{Weight of soil sample(w)}}{\text{Volume of the soil (V)}}$$

$$\text{Bulk Density of the Soil} = \frac{W}{V}(gm/cm^3) \qquad (3)$$

Soil Samples:

A. Top Soil (0-15cm depth)

Volume of measuring cylinder (V)

Weight of measuring empty cylinder (W_1)

Weight of measuring cylinder + soil sample (W_2)

$$\text{Bulk Density (top Soil)} = \frac{W_2 - W_1}{V} \qquad (4)$$

Sub-Soil (15cm – 30cm depth)

Weight of empty measuring cylinder = W_1

Weight of measuring cylinder + soil = W_2

$$\text{Bulk Density (sub Soil)} = \frac{W_2 - W_1}{V}$$

The biochemical oxygen demand (BOD) of the waste water sample was carried out for five (5) consecutive days non-stop, hence BOD_5. Thus, the BOD_5 was determined using the dissolved oxygen meter that was calibrated with 5% sodium sulphate solution. The probe of the meter was inserted into the sample after the meter was put on for about 10 minutes, and the reading of the dissolved oxygen (DO (1) was recorded in mg/l on the first day.

The sample was then incubated in a-300ml Wrinkler's bottle for a period of five (5) days at 20^{0C}, then the BOD_5 of the fifth (5^{th}) day was recorded by inserting the probe again into the sample. The difference in the DO (5) and DO (1) was recorded as the biochemical oxygen demand (BOD_5) of the sample for a period of five days (see table 3.1).

Thus, BOD_5 (mg/l) = DO (1) – DO (5) (5)

Where DO (1) = dissolved oxygen for the first day, mg/l

BOD_5 = biochemical oxygen demand for the 5^{th} day, mg/l

Therefore,

$$BOD5\ \left(\frac{mg}{L}\right) = \left[DO\ (1) - DO(5)\right] X \frac{\text{Volume of BOD bottle}}{\text{ml sample used}} \quad (6)$$

Where, $\frac{\text{Volume of BOD bottle}}{\text{ml sample used}}$ is called the Dilution Factor

Thus, volume of BOD bottle = 300ml
Volume of sample used = 50ml

Table 3.1: BOD_5 of polluted Water for Five Days

Parameter	Day	Sample 1 mg/l	Sample 2 mg/l	Sample 3 mg/l
DO (1)	1	7.6	7.4	7.2
D O(5)	5	6.1	6.4	6.7
BOD as calculated		9.0	6.0	3.0

3.1 ANALYSIS OF DATA USING STATISTICAL PACKAGE FOR SOCIAL SCIENCE (SPSS, Version 23) Level of significance = 0.05

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Top soil A	8	16.4939	28.42168	10.04858	-7.2672	40.2550	.10	68.19
Sub soil B	8	15.9667	28.77493	10.17347	-8.0897	40.0232	.00	67.70
Water Sample 1	8	8.9589	19.34245	6.83859	-7.2118	25.1296	.23	56.06
Water sample 2	8	9.2719	19.51671	6.90020	-7.0445	25.5883	.19	56.31
Water sample 3	8	12.8186	22.40986	7.92308	-5.9165	31.5537	.13	56.73
Total	40	12.7020	23.01492	3.63898	5.3415	20.0625	.00	68.19

Test of Homogeneity of Variances

Factors

Levene Statistic	df1	df2	Sig.
1.168	4	35	.342

ANOVA

Factors

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	406.618	4	101.655	.176	.949
Within Groups	20251.156	35	578.604		
Total	20657.774	39			

From the analysis above, it shows that the probability value (0.949) is greater than the alpha value (0.05) the researcher therefore concludes that oil spillage has a great impact on the soil and water samples of the Gokana local government area as it leads to environmental pollution, land pollution and water pollution.

4.0 DISCUSSION OF THE RESULTS

The electrical conductivity (E.C) of both the top soil and sub-soils is a measure of ionic concentration of the soil samples and is therefore a function of dissolved solutes. The

pH of the soil is within the permissible range. The dissolved oxygen (DO) in the polluted water was very low, hence could not support the microbial activity in the ecosystem and is responsible for the loss of biodiversity in the environment due to high level of pollution. Again, the higher the BOD value, the higher the water pollution.

Due to the higher level of minerals (heavy metals) in both soil and water especially the top soil, the polluted water is therefore hard; and the quantity of oil/grease from soil samples analyzed, indicated that reasonable quantity of oil was lost in the spillage. Thus, at a glance. the presence of oil/grease and heavy metals from the analysis were much higher when compared to international standards (WHO STDs) hence the water is polluted. Also, the variation with depth of the constituents determined in the AAS analysis of the soil samples represent the seepage of the spill in the soil, and which in effect, is a reflection of variation in concentration levels of those minerals (heavy metals) determined from top soil to sub-soil.

Therefore, both the heavy metals (minerals) and quantity of oil/grease present in the analysis were high when compared to International Standards (WHO), hence the soil is highly polluted. The same thing is applicable to other parameters such as nitrate-nitrogen, phosphate and phosphorus contained in the water and soil.

Furthermore, the oil/grease content in the impacted sites (media) - top soil and subsoil, 69.58% and 22.13% respectively, represent a high level of hydrocarbon contamination and loss in the study area of Gokana L.G.A. of Ogoniland in the Niger Delta region. From the findings of the experiments on the analysis of the polluted water, DO (dissolved oxygen) content was very low (7.6mg/l) when compared to WHO STD, (74mg/l) and this level of oxygen in the ecosystem does not encourage microbial activity, hence as oxygen became limiting a direct utilization of nitrate as a terminal electron acceptor would boost the availability of oxygen in the hydrocarbon (spill) impacted area of Gokana L.G.A. However, because concentration of macronutrients are well below those recommended by WHO (due to poor presence of oxygen in the impacted area/site) for the sustenance of ecosystems in areas of fishing and farming; introduction of biodegradable hydrocarbon and inorganic fertilizers in the oil-impacted site would enhance the soil nutritional value in the affected area.

These changes would also affect the growth of plants resulting to their stunted growth, poor fruit formation and chlorosis.

In the test of pH it was observed that pH is most important in determining the corrosive nature of water. It was observed that the lower the pH value the higher is the corrosion nature of water. This shows that pH has a positive correlation with electricity conductance and total alkalinity. The study also shows that conductivity has a significant correlation with temperature, pH value, alkalinity and total hardness. The analysis also shows that the probability value of Top soil A, Sub soil B, Water sample 2 and Water sample 3 are 0.535, 0.564, 0.979 and 0.750 respectively when compared with water sample 1. The analysis shows that the probability values are greater than the alpha value (0.05) which shows that oil spillage has a negative effect on soil and water samples in Gokana local government area.

The results of the research work revealed that the values of some parameters e.g chromium, cadmium, nickel, mercury, phosphate, etc were found to cross the standard limits in water samples. On comparing the results against drinking water quality based on World Health Organization laid down standards, it was found that some of the water samples were non-potable for human beings due to high concentration of one or the other parameters. Highly impure water has various effects on human beings, domestic purposes, as well as in industrial use. Such human beings get affected/ infected due to the presence of different bacteria and heavy metals present in the polluted water. It may affect different body

organs and physiological disorder. Hard water is not suitable for domestic use such as washing, bathing, cooking as well as other purposes. Hard water(poor quality water) is also not suitable for industrial and agricultural uses as it damages the delicate parts of machineries and affects the quality, stability and glossiness of the final products. The conductivity noticed was due to ionizable ions due to different dissolved solids (solutes) and conductivity increases the corrosive nature of water.

The pH changed due to different dissolved gases and solids that have potential effect as they affect mucous membrane in the body with the attendant bitter taste and corrosion. Due to the depletion of oxygen (reduced oxygen) in the polluted water, marine animals cannot survive.

CONCLUSION

In conclusion, the activities that came with the oil exploration and exploitation caused severe alterations to the environment (oil spills) which significantly have negative effects and some of the effects that came with petroleum development can be reduced or prevented basically by taking some steps in terms of prevention. Monitoring is also essential and critical but is lacking in the Gokana L.G.A of Niger Delta region especially in the creeks. Hence, the results of the experimental work enable the researcher to make the following observations:

i. The experimental results showed values which were very much higher than the WHO standards, thus indicating serious pollution of the environment earmarked.
ii. The causes of the spillage could be checked to prevent further accidental discharges. Oil wells should be properly automated and maintained.
iii. Proactive measures should be adopted to halt oil pipeline vandalism.

Recommendations

The oil producing communities should take a proactive stand against groups/individuals who engage in illegal oil activities such as bunkering and artisanal (crude) refining operations and vandalism of oil pipelines.

The Niger-Delta people should co-operate with the oil-producing companies in order to have a good community/industrial relations that would encourage new investment/employment opportunities and most importantly, a new culture of co-operation in the Niger-Delta region.

Finally, functional Water Borehole Projects in the three senatorial districts of Rivers state should be clinically monitored in terms of sampling and analysis of water to determine their quality for domestic, agricultural and industrial applications.

REFERENCES

Anifowose. B. & Onuoha, C. (2008). Assessing the Impact of Oil & Gas Transport on Nigeria's Environment. U21 Postgraduate Research Conference Proceedings 1, University of Birmingham UK. 36-48

Egbe, R.E. and Thompson, D. (2010). "Environmental Challenges of Oil Spillage for Families in Oil—Producing Communities of the Niger Delta Region." VEK Vol. 13, 4- 34.

Niger Delta Development Commission (NDDC). "The Niger Delta A Brief History Delta State Nigeria", 2005. 113-138

Odeyemi, O. and Ogunseitan, O.A (1985). Petroleum Industry and its Pollution Potential in Nigeria. Oil & Petroleum Pollution, Elsevier Applied Science Publishers Ltd, England, 2, 223-229

Odu, C.T.I., Nwoboshi, L.C and Esuruoso, O.F (1985). Environmental Studies (Soils and Vegetation) of the Nigerian Agip Oil Company Operation Areas. In. Proceedings of an International Seminar on the Petroleum Industry and the Nigerian Environment, NNPC, Lagos, Nigeria, 274-283.

Omofonmwan, S.l. and Odia, L.O. (2009). Oil Exploitation and Conflict in the Niger Delta Region of Nigeria. Journal of Human Ecology, 26(1), 25-30.

Onuoha, F.C. (2008). Oil Pipeline Sabotage in Nigeria. Dimensions, Actors and Implications for National Security L/C. African Security Review Institute for Security Studies, 17(3). www.isso.co.za

Opukri, C.O. and Ibaba, S.I. (2008). "Oil induced Environmental Degradation and Internal Population Displacement in the Nigeria's Niger- Delta." *Journal of* Sustainable *Development in Africa* Vol.1, No. l. Pp. 142-152

Osuji, L.C. (2001). Total Hydrocarbon Content of Soils, fifteen months after Eneka and Isiokpo Oil Spills. *J. Appl. Sci. Environ. Mgt*. **5**(2), 35-38.

Osuji, L.C., Adesiyan, S.O. and Obute, G.C. (2004). Post Impact Assessment of Oil Pollution in the Agbada West Plain of Niger Delta Nigeria. Field Reconnaissance and Total Extractable Hydrocarbon Content. Chem. Biodiv. **1**(10), 1569-1577.

Oyem, A., (2001). "'Christian call for action on Nigeria oil spill". Sage-Oxford's Christian Environmental Group. pp. 58-61

Ukoli, M.K. (2005). Environmental Factors in the Management of the Oil and Gas Industry in Nigeria.

Umeh, A.M. (2004). "The Industry and Environmental Pollution in Nigeria". A Paper Presented at the Conference on Environmental Resources in Nigeria. University of Ife, July, 2004.

United Nations Development Report (UNDP) (2006). Niger-Delta [22] [23] Development Human Report. United Nations Population Fund (UNPFA) (2002) Wadsworth, Dicks & Lavigne (1999). Approaches for Managing Marine Oil Spills. 164-235.

Zabbey, N. (2005). Impacts of Extractive Industries on the Biodiversity of the Niger Delta Region, Nigeria. Paper Delivered at National Workshop on Coastal and Marine Biodiversity Management, 7 - 9 Sept, 2005, Pyramid Hotel, Calabar, Cross River State, Nigeria 4(2), 172-218.